SWORN TRANSLATION

I, Jun INOH, hereby declare and state that I am knowledgeable of each of the English and Japanese languages and that I made the attached translation of the certified copy of Japanese Patent Application No. 2002-213990 from the Japanese language into English language and that I believe my attached translation to be accurate, true and correct to the best of my knowledge and ability.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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Declarant: Jun Inoh

Jun INOH

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[IDENTIFICATION OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] IMAGE DISPLAY DEVICE

[CLAIMS]

[Claim 1] An image display device which comprises an image display panel, in which two or more groups of particles having different colors and different charge characteristics are sealed between opposed two substrates, at least one of two substrates being transparent, and, in which the particles, to which an electrostatic field produced by a pair of electrodes arranged on one substrate or both substrates is applied, are made to move so as to display an image, characterized in that two substrates of the image display panel are connected by using a thermosetting adhesive or a photo-curing adhesive.

[Claim 2] The image display device according to claim 11, wherein the thermosetting adhesive or the photo-curing adhesive includes one or more groups of compounds having one of glycidyl group, acrylic group and methacrylic group.

[Claim 3] The image display device according to claim 1 or 2, wherein an average particle diameter of the particles is 0.1 - 50 μm.

[Claim 4] The image display device according to one of claims 1 - 3, wherein a charge amount of the particles in an absolute value is 10 - 100 μC/g.

[Claim 5] The image display device according to one of claims 1 - 4, wherein the particles are particles in which the maximum surface potential, in the case that the surface of particles is charged by a generation of Corona discharge caused by applying a voltage of 8 KV to a Corona discharge device deployed at a distance of 1 mm from the surface of the particles, is greater than 300 V at 0.3 second after the Corona discharge.

[DETAILED EXPLANATION OF THE INVENTION]

[0001]

[TECHNICAL FIELD OF THE INVENTION]

The present invention relates to an image display device, which comprises an image display panel enables to repeatedly display or delete images accompanied by flight and movement of particles utilizing Coulomb's force, and particularly relates to an image display device, which comprises an image display panel that realizes a good adhesion between the transparent substrate and the opposed substrate.

[0002]

[PRIOR ART]

As an image display device substitutable for liquid crystal display (LCD), image display devices with the use of technology such as an electrophoresis method, an electro-chromic method, a thermal method, dichroic-particles-rotary method are proposed.

[0003]

As for these image display device, it is conceivable as inexpensive visual display device of the next generation from a merit having wide field of vision close to normal printed matter, having smaller consumption with LCD, spreading out to a display for portable device, and an electronic paper is expected. Recently, electrophoresis method is proposed that microencapsulate dispersion liquid made up with dispersion particles and coloration solution and dispose the liquid between faced substrates.

[0004]

However, in the electrophoresis method, there is a problem that a response rate is slow by the reason of viscosity resistance because the particles migrate among the electrophoresis solution. Further, there is a problem of lacking imaging repetition stability, because particles with high specific gravity of titanium oxide is scattered within solution of low specific gravity, it is easy to subside, difficult to maintain a stability of dispersion state. Even in the case of microencapsulating, cell size is diminished to a microcapsule level in order to make it hard to appear, however, an essential problem was not overcome at all.

[0005]

Besides the electrophoresis method using behavior in the solution, recently, a method wherein electro-conductive particles and a charge transport layer are installed in a part of the substrate without using solution is proposed. However, the structure becomes complicated because the charge transport layer and further a charge generation layer are to be arranged. In addition, it is difficult to constantly dissipate charges from the electro-conductive particles, and thus there is a drawback on the lack of stability.

[0006]

[TASK TO BE SOLVED BY THE INVENTION]

Further, as one method of solving various problems mentioned above, it is known an image display device which comprises an image display panel, in which two or more groups of particles having different colors and different charge characteristics are sealed between two substrates, at least one of two substrates being transparent, and, in which the particles, to which an electrostatic field produced by a pair of electrodes having different potentials is applied, are made to move by means of Coulomb's force so as to display an image. In the image display device mentioned above, since it is a dry-type, it is possible to achieve rapid response, simple construction, inexpensive cost and excellent image stability. However, since it uses the particles for the image displaying, there is a drawback such that it is difficult to eliminate a positional deviation between the substrates and a leakage of the particles by sealing two substrates by means of adhesives under the condition such that the particles or the liquid powders are existent between them. Therefore, there is a drawback such that it is difficult to obtain the image display panel having high image display accuracy.

[0007]

The present invention relates to a dry type image display device having rapid response, simple construction, inexpensive cost and excellent stability and has for its object to provide the image display device comprising an image display panel which can achieve no positional deviation between substrates, prevent a leakage of particles and obtain a high image display accuracy.

[0008]

[SOLUTION FOR THE TASK]

According to the invention, an image display device which comprises an image display panel, in which two or more groups of particles having different colors and different charge characteristics are sealed between opposed two substrates, at least one of two substrates being transparent, and, in which the particles, to which an electrostatic field produced by a pair of electrodes arranged on one substrate or both substrates is applied, are made to move so as to display an image, is characterized in that two substrates of the image display panel are connected by using a thermosetting adhesive or a photo-curing adhesive.

[0009]

In the image display panel used in the image display device according to

the first embodiment of the fourth aspect of the invention, since two substrates i.e. a transparent substrate and an opposed substrate are connected by using the thermosetting adhesive or the photo-curing adhesive, it is possible to harden the adhesive in a short time by applying a heat or irradiating a light after setting two substrates through the adhesive at a predetermined position. As a result, it is possible to prevent the positional deviation between the substrates and the leakage of the particles. Moreover, it is possible to achieve the high image display accuracy of the image display panel.

[0010]

In the image display device according to the first embodiment of the fourth aspect of the invention, it is preferred that the thermosetting adhesive or the photo-curing adhesive includes one or more groups of compounds having one of glycidyl group, acrylic group and methacrylic group. Moreover, it is preferred that wherein an average particle diameter of the particles is 0.1 - 50 μm. Further, it is preferred that a charge amount of the particles in an absolute value are 10 - 100 μC/g. Furthermore, it is preferred that the particles are particles in which the maximum surface potential, in the case that the surface of particles is charged by a generation of Corona discharge caused by applying a voltage of 8 KV to a Corona discharge device deployed at a distance of 1 mm from the surface of the particles, is greater than 300 V at 0.3 second after the Corona discharge.

[0011]

[EMBODIMENTS OF THE INVENTION]

Figs. 1a to 1c are schematic views respectively showing another embodiments of the image display element of the image display panel used for the image display device according to the invention and its display driving method. In the embodiments shown in Figs. 1a to 1c, numeral 1 is a transparent substrate, numeral 2 is an opposed substrate, numeral 3 is a display electrode, numeral 4 is an opposed electrode, numeral 5 is a negatively chargeable particle, numeral 6 is a positively chargeable particle, numeral 7 is a partition wall and numeral 8 is an insulation member.

[0012]

Fig. 1a shows a state such that the negatively chargeable particles 5 and the

positively chargeable particles 6 are arranged between opposed substrates (transparent substrate 1 and opposed substrate 2). Under such a state, when a voltage is applied in such a manner that a side of the display electrode 3 becomes low potential and a side of the opposed electrode 4 becomes high potential, as shown in Fig. 1b, the positively chargeable particles 6 move to the side of the display electrode 3 and the negatively chargeable particles 5 move to the side of the opposed electrode 4 by means of Coulomb's force. In this case, a display face viewed from a side of the transparent substrate 1 looks like a color of the positively chargeable particles 6. Next, when a voltage is applied in such a manner that the side of the display electrode 3 becomes high potential and the side of the opposed electrode 4 becomes low potential by reversing potentials, as shown in Fig. 1c, the negatively chargeable particles 5 move to the side of the display electrode 3 and the positively chargeable particles 6 move to the side of the opposed electrode 4 by means of Coulomb's force. In this case, the display face viewed from the side of the transparent substrate 1 looks like a color of the negatively chargeable particles 5.

[0013]

The display states shown in Figs. 1b and 1c are repeatedly changeable only by reversing the potentials of a power source, and thus it is possible to change colors on the display face reversibly by reversing the potentials of the power source as mentioned above. The colors of the particles can be arbitrarily selected. For example, when the negatively chargeable particles 5 are white color and the positively chargeable particles 6 are black color, or, when the negatively chargeable particles 5 are black color and the positively chargeable particles 5 are white color, a reversible image display between white color and black color can be performed. In this method, since the particles are once adhered to the electrode by means of an imaging force, a display image can be maintained for a long time after a voltage apply is stopped, thereby showing an excellent memory property.

[0014]

In the present invention, since the chargeable particles fly and move in the gas, the response rate of the image display is extremely fast and the response rate of shorter than 1 msec may be possible. Moreover, it is not necessary to use an

orientation film and a polarizing plate as the liquid crystal display, and thus it is possible to make the structure simple and to realize the image display device having a large display area at a lower cost. In addition, it is stable with respect to a temperature variation and can be used in a wide temperature range from a low temperature to a high temperature. Further, it is not affected by an angle of visual field and has a high reflection coefficient. Therefore, it is easily viewable and has low electric power consumption. Furthermore, it has an excellent memory property and thus it is not necessary to use an electric power when the image is to be maintained.

[0015]

Fig. 2 is a schematic view showing still another embodiment of the image display element of the image display panel according to the invention. In the embodiment shown in Fig. 2, irrespective of the embodiments shown in Figs. 1a to 1c, the display electrode 3 is arranged to the transparent substrate 1 and the opposed electrode 4 is arranged to the opposed substrate 2. In the embodiment shown in Fig. 2, it is necessary to use a transparent electrode as the display electrode 3. On the other hand, in the embodiments shown in Figs. 1a to 1c, since an opaque electrode can be used as the display electrode 3, it is possible to use a metal electrode having an inexpensive cost and a low resistance such as copper, aluminum and so on, and thus it is preferred.

[0016]

The feature of the image display device according to the invention is to connect the transparent substrate 1 and the opposed substrate 2 by using a thermosetting adhesive or a photo-curing adhesive in the image display panel having the structure mentioned above. With reference to Figs. 3a - 3c, the connection between the transparent substrate 1 and the opposed substrate 2 in the image display panel 11 of the image display device according to the invention will be explained specifically in detail as follows.

[0017]

At first, two substrates are prepared. That is, as shown in Fig. 3a, the transparent substrate 1, on which the display electrode 3 is arranged, and the opposed substrate 2, on which the opposed electrode 4 is arranged, are prepared. The display electrode 3 is arranged correspondingly to respective image display

elements 12, and a gap for setting the partition wall 7 is arranged between the display electrodes 3 and 3. In the same manner, the opposed electrode 4 is arranged corresponding to respective image display elements 12, and the partition wall 7 is arranged between the opposed electrodes 4 and 4.

[0018]

Then, an adhesive for sealing is prepared, and a particle filling process and an adhesive coating process are performed. At first, as the adhesive, the thermosetting adhesive or the photo-curing adhesive, preferably, an adhesive including one of more groups of compounds having one of glycidyl group, actylic group and methacrylic group is prepared. If the adhesive is the thermo-setting adhesive or the photo-curing adhesive, any known adhesives may be used. As a preferred example, the adhesive for sealing, in which 40 parts by weight of neopenthyl glycol methacrylate and 2 parts by weight of benzoil peroxide are added with respect to 100 parts by weight of TO-SO EVA uletrasen UE750R, is prepared. Then, as shown in Fig. 3b, the negatively chargeable particles 5 with a white color and the positively chargeable particles 6 with a black color are filled in a space constituting the image display element 12 between the partition walls 7, and the thus prepared adhesive 13 is coated to a frame portion defined at a periphery of the transparent substrate 1 by means of a dispenser.

[0019]

Finally, a setting process of the two substrates and a hardening process of the adhesive for sealing by a heat or a light irradiation are performed. That is, as shown in Fig. 3c, the setting is performed by adhering the transparent substrate 1 and the opposed substrate 2 via the adhesive 13. Then, heat or light is applied to the setted substrates in accordance with a type of the adhesive 13 (as one example, in the case of the adhesive having the composition mentioned above, heating at 130 °C for 10 minutes) so as to harden the adhesive for sealing. The image display panel 11 is obtained by performing the processes mentioned above.

[0020]

In the embodiments shown in Figs. 3a - 3c, three image display elements 12 are arranged in a cross section shown in these figures, but it is a matter of course that the number is not limited to three. Moreover, in the embodiment mentioned

above, the image display panel having the construction shown in Fig. 2, in which the display electrode 3 is arranged to the transparent substrate 1 and the opposed electrode 4 is arranged to the opposed substrate 2, is explained, but it is apparent that the same effects can be obtained by the image display panel having the construction shown in Fig. 1, in which the display electrode 3 and the opposed substrate 4 are arranged to the opposed substrate 2.

[0021]

Hereinafter, the substrate, the respective members used in the image display device according to the invention will be explained.

With respect to the substrate, at least one of the substrates is the transparent substrate through which a color of the particles can be observed from outside of the device, and it is preferred to use a material having a high transmission factor of visible light and an excellent heat resistance. Whether a flexibility of the substrate is necessary or not is suitably selected in accordance with its use. For example, it is preferred to use a material having flexibility for the use of electronic paper and so on, and it is preferred to use a material having no flexibility for the use of a display of portable device such as mobile phone, PDA, laptop computer and so on.

[0022]

Examples of the substrate material include polymer sheets such as polyethylene terephthalate, polymer sulfone, polyethylene, polycarbonate, polyimide or acryl and inorganic sheets such as glass, quartz or so. The opposed substrate may be transparent or may be opaque. The thickness of the substrate is preferably 2 to 5000 μm, more preferably 5 to 1000 μm. When the thickness is too thin, it becomes difficult to maintain strength and distance uniformity between the substrates, and when the thickness is too thick, vividness and contrast as a display capability degrade, and in particular, flexibility in the case of using for an electronic paper deteriorates.

[0023]

Moreover, as shown in Figs. 1a - 1c and Fig. 2, it is preferred to arrange the partition wall 7 at a periphery of respective display elements. The partition wall may be arranged only in a parallel direction. In this manner, it is possible to prevent an unnecessary movement of the particles in a direction parallel to the

substrate, to help a repeatedly endurance property and a memory maintaining property and to improve a strength of the image display panel by making a distance between the substrates even and strong. The formation method of the partition wall is not particularly restricted, however, a screen printing method wherein pastes are overlapped by coating repeatedly on a predetermined position by screen plate; a sandblast method wherein partition materials are painted with a desired thickness entirely over the substrate and then after coating resist pattern on the partition materials which is wanted to be left as a partition, jetting abrasive to cut and remove partition materials aside from the partition part; lift-off method (additive method) wherein a resist pattern is formed on the substrate using photosensitive polymer, and then after burying paste into a resist recess, removing the resist; photosensitive paste method wherein the photosensitive resin composition containing the partition materials is applied over the substrate and then obtaining a desired pattern by exposure & developing; and mold formation method wherein paste containing the partition materials is applied over the substrate and then forming a partition by compression bonding & pressure forming the dies having rugged structure; and so on are adopted. Further, modifying the mold formation method, relief embossing method wherein a relief pattern provided by a photosensitive polymer composition is used as a mold is also adopted.

[0024]

In the case of arranging a display electrode on the transparent substrate, the electrode may be formed of electroconductive materials, which are transparent and having patter formation capability. As such electroconductive materials, metals such as aluminum, silver, nickel, copper and gold, or transparent electroconductive metal oxides such as ITO, electroconductive tin oxide and electroconductive zinc oxide formed in the shape of thin film by sputtering method, vacuum vapor deposition method, CVD method, and coating method, or coated materials obtained by applying the mixed solution of an electroconductive agent with a solvent or a synthetic resin binder are used.

[0025]

Typical examples of the electroconductive materials include cationic polyelectrolyte such as benzyltrimethylammonium chloride, tetrabutylammonium

perchlorate and so on, anionic polyelectrolyte such as polystyrenesulfonate, polyacrylate, and so on, or electroconductive fine powders of zinc oxide, tin oxide, or indium oxide. Additionally, the thickness of the electrode may be suitable unless the electroconductivity is absent or any hindrance exists in optical transparency, and it is preferable to be 3 to 1000 nm, more preferable to be 5 to 400 nm. The foregoing transparent electrode materials can be employed as the opposed electrode, however, non-transparent electrode materials such as aluminum, silver, nickel, copper, and gold can be also employed.

[0026]

It is preferred that an insulation coating layer is formed on the electrode so as not to reduce charges of the charged particles. As such insulation coating layer, if use is made of a positively chargeable resin with respect to the negatively chargeable particles and a negatively chargeable resin with respect to the positively chargeable particles, the charges of the particles are to be difficult to reduce and it is particularly preferable.

[0027]

As the particles, although any of colored particles negatively or positively chargeable having capability of flying and moving by Coulomb's force are employable, spherical particles with light specific gravity are particularly preferable. The average particle diameter is preferable to be 0.1 to 50 μm, particularly to be 1 to 30 μm. When the particle diameter is less than this range, charge density of the particles will be so large that an imaging force to an electrode and a substrate becomes too strong; resulting in poor following ability at the inversion of its electric field, although the memory characteristic is favorable. On the contrary, when the particle diameter exceeds the range, the following ability is favorable, however, the memory characteristic will degrade.

[0028]

Although the method for charging the particles negatively or positively is not particularly limited, a corona discharge method, an electrode injection-charge method, a friction charge method and so on are employable. It is preferred that a charge amount of the particles in an absolute value is 10 - 100 μC/g, particularly 20 - 60 μC/g. If the charge amount is lower than this range, a response speed with respect to a variation of an electric filed becomes slow and

memory characteristics become low. If the charge amount is higher than this range, an image force with respect to the electrode and the substrate becomes too strong, and a following property in the case of inverting an electric field becomes deteriorated while the memory characteristics are excellent.

[0029]

Because it is necessary for the particles to hold the charged electric charge, insulating particles with the volume specific resistance of 1×10^{10} Ω·cm or greater are preferable, and in particular, insulating particles with the volume specific resistance of 1×10^{12} Ω·cm or greater are more preferable. Further, the particles with slow charge attenuation property evaluated by the measuring method below are more preferable.

[0030]

That is, the particles are made into a film having a thickness of 5 - 100 μm by means of a press method, a heating/melting method, a casting method and so on, and the voltage of 8 kV is applied to a Corona generator disposed with a distance of 1 mm to the film surface so as to generate Corona discharge, which charges the film surface. Then, the change of the surface potential is measured to determine the suitability. In this occasion, it is preferable to select the material whose maximum surface potential will be 300 V or greater after 0.3 seconds, more preferable to select the material whose maximum surface potential will be 400 V or greater after 0.3 second as the material for composing the particles.

[0031]

Additionally, the foregoing surface potential is measured by means of an instrument (CRT2000 produced by QEA Inc.) as shown in Fig. 4. In this instrument both end portions of a roll shaft being held with chuck 21, compact scorotron discharger 22 and surface potential meter 23 are spaced with predetermined interval to form a measurement unit. Facedly deploying the measurement unit with a distance of 1 mm from the surface of the particles, and by moving the measurement unit from one end portion of the roll shaft to the other end portion with an uniform speed, with the state that the roll shaft remains stopping and while giving surface charge, a method of measuring its surface potential is preferably adopted. Moreover, measurement environment should be

settled at the temperature of 25 ± 3°C and the humidity of 55 ± 5% RH.

[0032]

If the particles satisfy electrostatic property and so on, the particles may be formed by any materials. For example, it is formed by resin, charge control agent, coloring agent, inorganic additive and so on, or, by coloring agent and so on only.

[0033]

Typical examples of the resin include urethane resin, urea resin, acrylic resin, polyester resin, acryl urethane resin, acryl urethane silicone resin, acryl urethane fluorocarbon polymers, acryl fluorocarbon polymers, silicone resin, acryl silicone resin, epoxy resin, polystyrene resin, styrene acrylic resin, polyolefin resin, butyral resin, vinylidene chloride resin, melamine resin, phenolic resin, fluorocarbon polymers, polycarbonate resin, polysulfon resin, polyether resin, and polyamide resin. Two kinds or more of these may be mixed and used. For the purpose of controlling the attaching force with the substrate, acryl urethane resin, acryl silicone resin, acryl fluorocarbon polymers, acryl urethane silicone resin, acryl urethane fluorocarbon polymers, fluorocarbon polymers, silicone resin are particularly preferable.

[0034]

Examples of the electric charge control agent include, but not particularly specified to, negative charge control agent such as salicylic acid metal complex, metal containing azo dye, oil-soluble dye of metal-containing (containing a metal ion or a metal atom), the fourth grade ammonium salt-based compound, calixarene compound, boron-containing compound (benzyl acid boron complex), and nitroimidazole derivative. Examples of the positive charge control agent include nigrosine dye, triphenylmethane compound, the fourth grade ammonium salt compound, polyamine resin, imidazole derivatives, etc. Additionally, metal oxides such as ultra-fine particles of silica, ultra-fine particles of titanium oxide, ultra-fine particles of alumina, and so on; nitrogen-containing circular compound such as pyridine, and so on, and these derivates or salts; and resins containing various organic pigments, fluorine, chlorine, nitrogen, etc. can be employed as the electric charge control agent.

[0035]

As for a coloring agent, various kinds of organic or inorganic pigments or dye as will be described below are employable.

[0036]

Examples of black pigments include carbon black, copper oxide, manganese dioxide, aniline black, and activate carbon. Examples of yellow pigments include chrome yellow, zinc chromate, cadmium yellow, yellow iron oxide, mineral first yellow, nickel titanium yellow, navel orange yellow, naphthol yellow S, hanzayellow G, hanzayellow 10G, benzidine yellow G, benzidine yellow GR, quinoline yellow lake, permanent yellow NCG, and tartrazinelake. Examples of orange pigments include red chrome yellow, molybdenum orange, permanent orange GTR, pyrazolone orange, Balkan orange, indusren brilliant orange RK, benzidine orange G, and Indusren brilliant orange GK. Examples of red pigments include red oxide, cadmium red, diachylon, mercury sulfide, cadmium, permanent red 4R, lithol red, pyrazolone red, watching red, calcium salt, lake red D, brilliant carmine 6B, eosin lake, rhodamine lake B, alizarin lake, and brilliant carmine 3B.

[0037]

Examples of purple pigments include manganese purple, first violet B, and methyl violet lake. Examples of blue pigments include Berlin blue, cobalt blue, alkali blue lake, Victoria blue lake, phthalocyanine blue, metal-free phthalocyanine blue, partially chlorinated phthalocyanine blue, first sky blue, and Indusren blue BC. Examples of green pigments include chrome green, chromium oxide, pigment green B, Malachite green lake, and final yellow green G. Further, examples of white pigments include zinc white, titanium oxide, antimony white, and zinc sulphide.

[0038]

Examples of extenders include baryta powder, barium carbonate, clay, silica, white carbon, talc, and alumina white. Furthermore, there are Nigrosine, Methylene Blue, rose bengal, quinoline yellow, and ultramarine blue as various dyes such as basic dye, acidic dye, dispersion dye, direct dye, etc. These coloring agents may be used alone or in combination of two or more kinds thereof. Particularly, carbon black is preferable as the black coloring agent, and titanium oxide is preferable as the white coloring agent.

[0039]

Although the manufacturing method of the particles is not specifically restricted, mixing/grinding method or polymerization method for producing toner of electrophotography is, for example, similarly employable. Further the method of coating resin or charge control agent and so on over the surface of powders such as inorganic or organic pigments is also employable.

[0040]

The distance between the transparent substrate and the opposed substrate is suitably adjusted in a manner where the particles can move and maintain the contrast of image display; however, it is adjusted usually within 10 to 5000 μm, preferably within 30 to 500 μm. The particle filling amount (volume occupying rate) of the particles existing in the space between the faced substrates is preferable to be 10 to 90%, more preferable to be 30 to 80%.

[0041]

The image display device according to the invention is applicable to the image display unit for mobile equipment such as notebook personal computers, PDAs, cellular phones and so on; to the electric paper for electric book, electric newspaper and so on; to the bulletin boards such as signboards, posters, blackboards and so on; and to the image display unit for electric calculator, home electric application products, auto supplies and so on.

[0042]

[EFFECT OF THE INVENION]

As clearly understood form the above explanations, in the image display device according to the invention, since two substrates i.e. a transparent substrate and an opposed substrate are connected by using the thermosetting adhesive or the photo-curing adhesive, it is possible to harden the adhesive in a short time by applying a heat or irradiating a light after setting two substrates through the adhesive at a predetermined position. As a result, it is possible to prevent the positional deviation between the substrates and the leakage of the particles. Moreover, it is possible to achieve the high image display accuracy of the image display panel.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1] Figs. 1a - 1c are schematic views respectively showing one

embodiment in an image display element of the image display panel constituting the image display device according to the invention and its display driving theory.

[Fig. 2] Fig. 2 is a schematic view illustrating another embodiment of the structure in the image display element of the image display panel constituting the image display device according to the invention.

[Fig. 3] Figs. 3a - 3c are schematic views respectively depicting a step of connecting the substrates in the image display device according to the invention.

[Fig. 4] Fig. 4 is a schematic view showing a method of measuring a surface potential of a particle used in the image display device according to the invention.

[DESCRIPTION OF REFERENCE SYMBOLS]

1 transparent substrate

2 opposed substrate

3 display electrode

4 opposed electrode

5 negatively chargeable particles

6 positively chargeable particles

7 partition wall

8 insulation member

11 image display panel

12 image display element

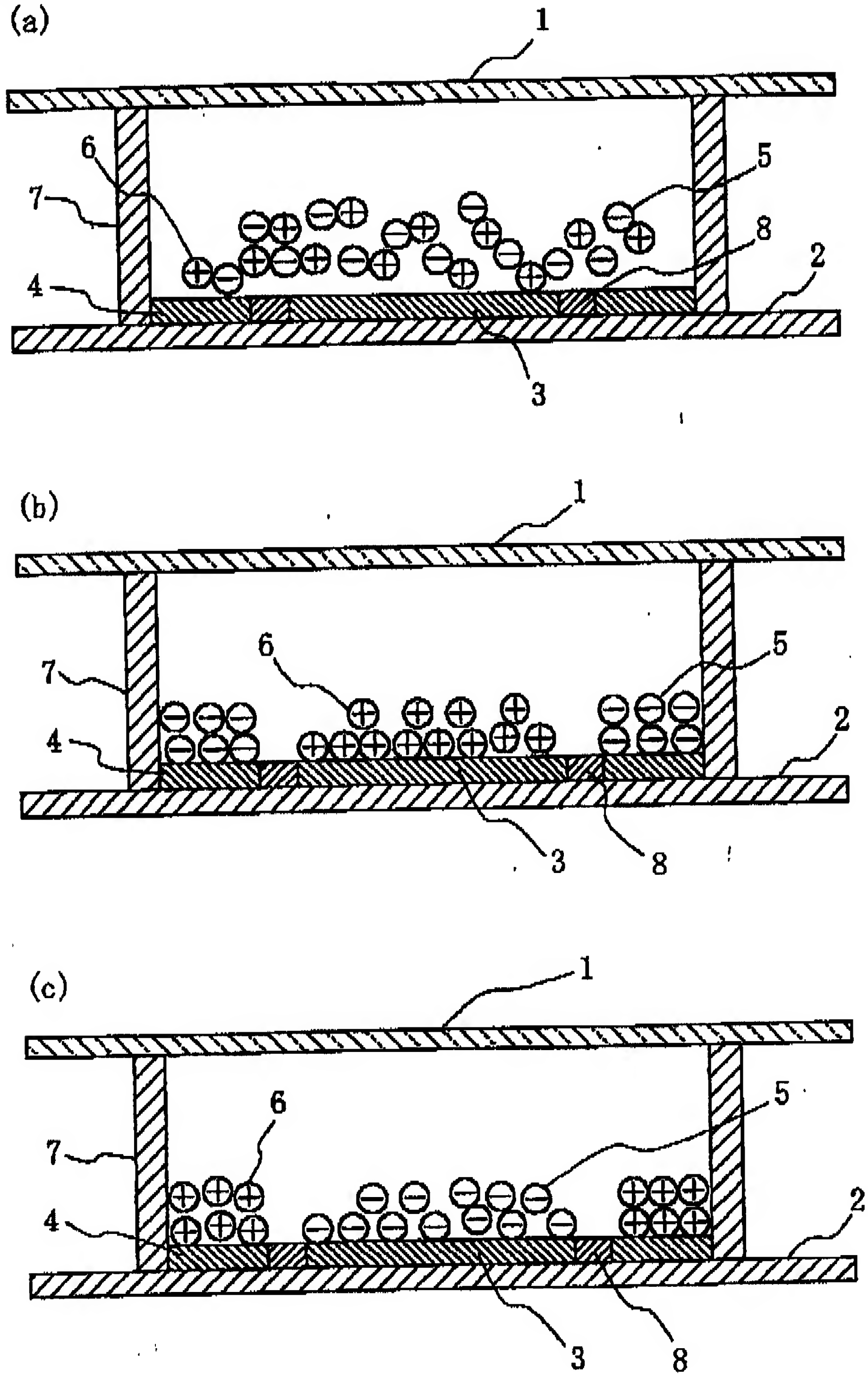
13 adhesives for seal

21 chuck

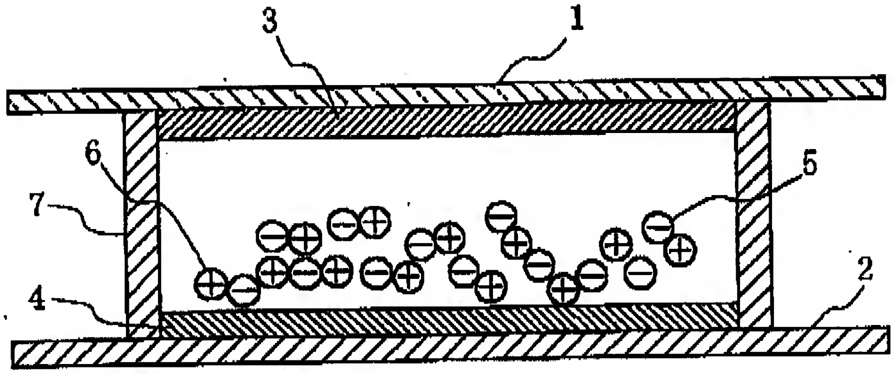
22 scorotron discharger

23 surface potential meter

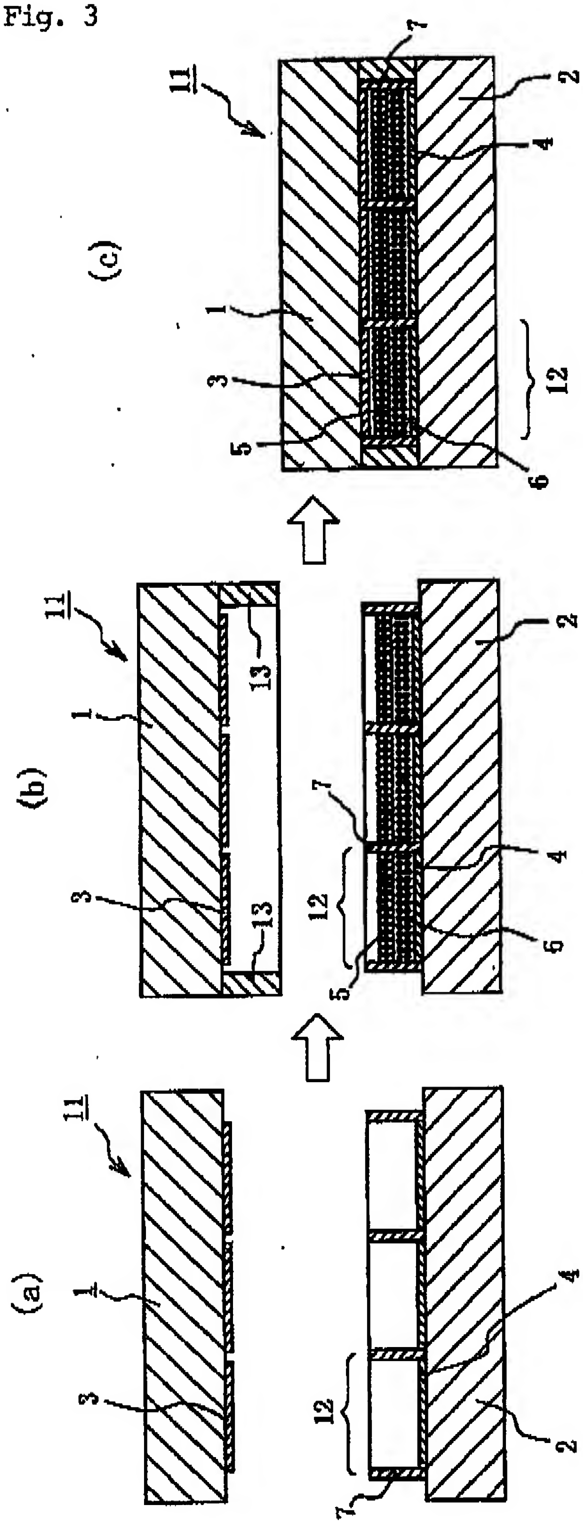
【書類名】　図面
Identification of Document Drawings
【図１】
Fig. 1



【図２】
Fig. 2

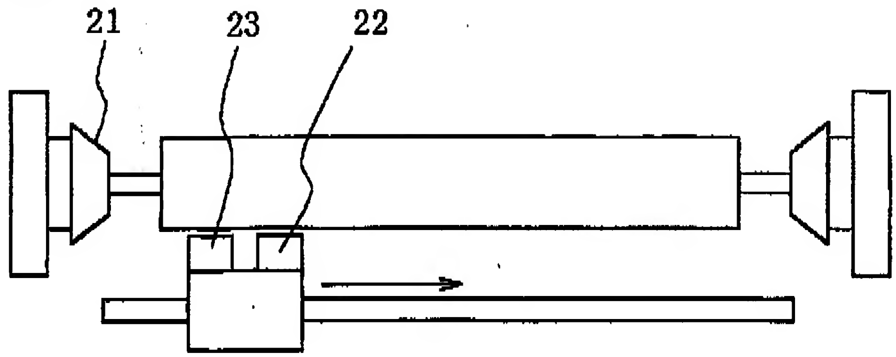


【図３】
Fig. 3



【図４】

Fig. 4



[IDENTIFICATION OF DOCUMENT] ABSTRACT

[ABSTRACT]

[TASK] To provide the image display device comprising an image display panel which can achieve no positional deviation between substrates, and obtain a high image display accuracy.

[SOLUTION] In an image display device which includes an image display panel 11, in which two or more groups of particles 5, 6 having different colors and different charge characteristics are sealed between opposed two substrates 1, 2, at least one of two substrates being transparent, and, in which the particles, to which an electrostatic field produced by a pair of electrodes 3, 4 arranged on one substrate or both substrates is applied, are made to move so as to display an image, two substrates 1, 2 of the image display panel 11 are connected by using a thermosetting adhesive or a photo-curing adhesive 13.

[SELECTED FIGURE] Fig. 3